UNITED STATES MARINE CORPS
Logistics Operations School
Marine Corps Combat Service Support Schools
Training Command
PSC Box 20041
Camp Lejeune, North Carolina 28542-0041

LVSM 7308

**STUDENT OUTLINE**

MAINTAIN THE MK18A1 HYDRAULIC SYSTEM

**LEARNING OBJECTIVES:**

1. Terminal Learning Objectives: Given an MK48/18A1, tools, test equipment, and references, repair a faulty MK18 hydraulic system, per the references. (3521.13.27)

2. Enabling Learning Objectives:

a. Given an MK48/18A1, tools, test equipment, TM 09470B-20/2 and TM 09470B-34/3, test the MK18A1 hydraulic system components for serviceability, per the references. (3521.13.27d)

b. Given an MK48/18A1, tools, test equipment, TM 09470B-20/2 and TM 09470B-34/3, perform adjustments on the MK18A1 hydraulic system components, per the references. (3521.13.27e)

c. Given an MK48/18A1, tools, test equipment, TM 09470B-20/2, and TM09470B-34/3, replace components of the MK18A1 hydraulic system, per the references. (3521.13.27f)

d. Given TM 09470B-20/2, TM 09470B-34/3, and partial statements pertaining to the MK18A1 hydraulic system, complete the partial statements to describe the procedures used to diagnose a malfunctioning MK18A1 hydraulic system, per the references. (3521.13.27g)

**OUTLINE:**

**1. OVERVIEW AND PRINCIPLES OF OPERATION OF THE HYDRAULIC SYSTEM COMPONENTS**

a. The major hydraulic components used on the MK18A1 are:

(1) Manual control valves located on the left side,

(2) Hydraulic filter to maintain cleanliness of the hydraulic system,

(3) Pressure intensifier that increases the hydraulic pressure,

(4) Main frame cylinders used to raise and lower the load handling system (LHS) main frame,

(5) Hook arm cylinders used to pivot the LHS hook arm attached to the main frame, and

(6) Winch that is driven by a hydraulic motor.

b. Hydraulic oil for the MK18A1 hydraulic system is provided by the MK48 through a supply hose and returned to the hydraulic reservoir through a return hose. Hydraulic oil under pressure from the MK48 passes through the intensifier to increase pressure because of the heavy loads carried by the MK18A1. From the intensifier, oil passes through the filter, then on to the manual control valve assembly. When a manual control lever on the valve assembly is activated, it directs oil to the main frame cylinders, hook arm cylinders, or the winch motor, to raise or lower a load.

## 2. IDENTIFICATION, LOCATION, AND FUNCTION OF THE HYDRAULIC COMPONENTS USED ON THE MK18A1

a. Pressure Intensifier

(1) The pressure intensifier consists of the following three parts:

(a) Inlet manifold,

(b) Intensifier, and

(c) Intensifier control.

(2) The inlet manifold receives the hydraulic oil from the MK48 at a flow rate of 20 gpm.

(3) The intensifier unit is a unique component. The intensifier can increase the incoming hydraulic oil pressure from the MK48 from 3200 psi to the maximum relief valve setting of 4200 psi.

(4) The intensifier is controlled by an internal pressure valve and check valve. Increased load to the MK18A1 hydraulic system requires an increase in oil pressure; the pressure valve activates to furnish the increase by redirecting the flow of oil internally.

b. High Pressure Filter

(1) High pressure oil from the intensifier passes through the filter. This filter is a replaceable element type. To access the element, the bowl, which is sealed with an "O"-ring and a back-up ring, must be removed. A drain plug is provided at the bottom of the bowl.

(2) A 50 psi by-pass valve is located in the filter head. The by-pass valve will open when restriction in the filter element has reached the valve setting.

(3) Always use the correct element to assure proper filtration. Contamination and poor filtration cause most of the hydraulic system failures.

c. Control Valves

(1) After filtering, the hydraulic oil goes to the manual control valves, which provide individual controls for the hook arm, main frame, and winch hydraulic circuits. All hydraulic oil goes through a safety valve first, then to the hydraulic circuit through its control. Each circuit has a proportionate control that varies output depending on the amount of manual control valve handle travel. The function of each valve is as follows:

(a) The safety valve acts as a "Dead Man Safety" and must be held in the ON position for the remaining hydraulic controls to operate. This is accomplished by controlling the hydraulic oil pressure from the pump, prior to entering the remaining control valves.

(b) The main frame load/unload valve extends and retracts the main frame cylinders to raise or lower the main frame.

(c) The hook arm load/unload valve extends and retracts the hook arm cylinders, moving the hook arm up or down.

(d) The winch in/out valve controls the winch cable operation in or out and is unique because of a 2537 psi relief built into the valve for winch operation.

(2) Each control valve consists of three parts which are the:

(a) Body, containing the valve directional spool and other internal valves,

(b) Lever housing, with the manual lever attached which controls the directional spool manually, and

(c) Solenoid assembly, used to control the spool electrically by the remote control unit (RCU).

(3) For RCU operation, the solenoid controls the directional spool and pilot oil pressure in the solenoid assembly. The pilot oil pressure, in turn, moves the valve directional spool during operations using the RCU.

(4) The solenoid assemblies for the main frame, hook arm, and winch valve are the same. The solenoid assembly for the safety valve is different.

(5) Each of the body sections are different internally. The body section for the winch control also has the internal pressure relief that is necessary for the winch hydraulic system.

(6) At the end of the bank of valves, attached to the safety valve, is the inlet cover assembly. This assembly contains a pressure relief valve that limits system capabilities and a pressure-regulating valve for the pilot pressure system.

(7) In between the safety valve section and main frame section is an adapter block which has a port for the pilot pressure electric switch. This switch, when closed by pilot pressure, provides voltage to the hour meter for recording operation time for the MK18A1 hydraulic system.

(8) Another important valve is the check valve, located in a manifold behind the control valves. This check valve, which is in the valve return line, senses the back pressure from a plugged hydraulic cooler on the MK48. When this occurs, the check valve by-passes the hydraulic cooler and sends the return hydraulic fluid from the MK18A1 directly back to the hydraulic reservoir. The valve by-passes at 50 psi.

d. Main Frame Cylinders

(1) There are two main frame cylinders that attach to the LHS frame and main frame. They are conventional-type, double-acting cylinders, utilizing a piston with rings and seals.

(2) At the head end of each cylinder, there is a manifold that directs the oil into and out of the cylinder. This manifold also contains the following valves:

(a) Two counterbalance valves (similar to holding valves) that hold the load in the event there is a loss of hydraulic pressure,

(b) An electrically activated transit valve and solenoid used to relieve pressure on both ends of the cylinder when the MK18A1 is in transport, and

(c) Four check valves, which are part of the transit valve system.

e. Hook Arm Cylinders

(1) There are two hook arm cylinders that attach to the hook arm and main frame. They are conventional-type, double-acting cylinders utilizing a piston with rings and seals.

(2) At the head end of each cylinder is a manifold that directs oil into and out of the cylinder. The manifold also contains two counterbalance valves which will hold the load in the event of a hydraulic pressure loss.

f. Hydraulic Winch

(1) The winch consists of a hydraulic motor, valve manifold, wet brake, and gear case.

(2) The hydraulic motor is a gear-type unit. It converts hydraulic power, delivered by the MK48, into mechanical power. Speed of the motor is controlled by the hydraulic fluid flow in gpm and the pressure in psi that can be developed determines power.

(3) The valve manifold directs the oil into and out of the hydraulic motor, but it performs two other functions for the winch operation with internal valves.

(a) One valve is the counterbalance valve. This valve limits the speed of the hydraulic motor during unloading (winching out) operations to compensate for the load. Speed limiting is accomplished by controlling the hydraulic oil pressure at the inlet and outlet of the motor. During loading operations (winching in), the counterbalance valve allows free flow in and out of the motor. The counterbalance valve assures control of the load and actually works like a brake.

(b) Another valve, internally in the manifold, is a shuttle-type valve that is used to control the winch brake. The winch brake is a multi-disc, wet-type that is spring-applied and hydraulically-released. With no hydraulic pressure, the brake is applied. When the control valve is positioned for winching in, oil pressure will be directed to the motor and also to the brake, by the shuttle valve. When the control valve is positioned for winching out, oil is directed to the motor and also to the

brake, by the shuttle valve moving in the other direction. The shuttle valve is not removable.

(4) The winch brake, as discussed above, is a multi-disc wet-type. Without hydraulic pressure of at least 270 psi, the spring force on the friction discs will generate the braking force. This force is sufficient to hold the rated load of the winch. Therefore, should pressure be lost due to some hydraulic component failure, the brake will set and immediately retain the load until pressure is restored. It is not recommended that this item be repaired in the field.

(5) The gear case is the winch drum. Gears inside, used for gear reduction, increase the torque furnished by the hydraulic motor to drive the drum. The gears run in an oil bath within the drum.

g. Hydraulic System Schematic

(1) This symbolic diagram of the hydraulic system components ties together the hydraulic system.

(a) The MK48 supplies hydraulic power from its hydraulic system to the MK18A1 pressure intensifier. Some of the hydraulic oil returns to the MK48 when the pressure is being intensified.

(b) From the intensifier, hydraulic oil goes to the control valve body. At the valve body, the inlet section contains relief and flow control valves.

(c) This next section contains the safety valve and when activated, oil flows to all of the control valve sections:

(1) Main frame,

(2) Hook arm, and

(3) Winch.

(d) With the safety valve activated and any of the other valves activated, oil will flow to and from that particular cylinder or winch in the manner in which the lever is moved. There is a supply and return line on the vehicle. This picture is only symbolic.

(e) For remote control operation, the safety valve and any of the other three valves will be activated electrically. The small electrical symbol signifies the electrical part of each valve.

(f) Return oil from the valve body goes back to the MK48.

(2) Next, we will work with the actual MK18A1 hydraulic schematic that will be modified to show various hydraulic circuits color-coded.

(a) Hydraulic circuits are to be color-coded according to a color key. For example, use orange for low MK48 pressure, red for intensified pressure, green for supply and return oil, and yellow for pilot pressure.

(b) The various hydraulic symbols will be explained as the hydraulic circuits are traced.

(c) All the hydraulic circuits should be explained.

## 3. MAINTENANCE RESPONSIBILITIES RELATIVE TO THE MK18A1 HYDRAULIC SYSTEM

a. Maintenance personnel are responsible for troubleshooting, repairing, and replacing all hydraulic components. Some of this maintenance involves third echelon capability.

b. The complete hydraulic system involves the MK48. For any troubleshooting, repairs, or replacement of parts on the MK48 hydraulic system, it is necessary to refer to MK48 technical manuals.

(1) Organizational Maintenance. Organizational maintenance personnel have the responsibility of troubleshooting malfunctions and inspecting all of the hydraulic components. The Organizational mechanic is specifically responsible for replacing the:

(a) Hydraulic filter,

(b) Filter head assembly, and

(c) Hoses and tubes.

(2) Intermediate Maintenance. Intermediate maintenance personnel are responsible for troubleshooting malfunctions and:

(a) Hook arm cylinder manifold repair,

(b) Hook arm cylinder repair or replacement,

(c) Main frame cylinder manifold repair,

(d) Main frame cylinder repair or replacement,

(e) Check valve repair or replacement,

(f) Pressure intensifier repair or replacement, and

(g) Manual control valve repair or replacement.

## 4. DIAGNOSE A MALFUNCTIONING HYDRAULIC SYSTEM

a. Troubleshooting Procedures

(1) Chapter 2, paragraph 2-8 of TM 09470B-20/2 contains the troubleshooting procedures, troubleshooting symptoms index, and malfunctions. For each malfunction, there is a test or inspection, plus the corrective action.

(2) To troubleshoot a malfunction, proper procedures are important. These procedures are:

(a) Obtain as much information from the operator as possible about the malfunction.

(b) Never overlook the possibility that the problem may be of simple origin and repaired with a simple adjustment.

(c) Use all available test equipment to help find and locate troubles.

(d) Whenever possible, isolate the system first and then the component causing the malfunction.

(e) Remember, for every failed part there is a cause. Whenever possible, determine the cause of the failure before assuming the malfunction is fully repaired.

(f) Use standard hydraulic theories and principles when troubleshooting the RBU.

(g) To quickly find the troubleshooting procedure, you need to use the Troubleshooting Symptom Index. To use this index, first determine if the malfunction is present using the remote control unit (RCU) only, or if the malfunction also occurs using the manual controls. Then find the listed symptom which best matches your actual symptom. Where the malfunction occurs using the RCU only, find a listed symptom with an X in the REMOTE column and nothing in the MANUAL column. Where the malfunction occurs using the RCU and the manual controls, find a listed symptom with an X in both the REMOTE and MANUAL columns. To determine if the malfunction occurs using the RCU and

using the manual controls, disconnect the RCU then check the system operation using the manual controls. For this lesson on the hydraulic system, "remote and manual" control type malfunctions will be diagnosed.

(h) Follow each of the malfunction steps (tests). Skipping steps will ensure improper results.

b. Troubleshooting Notes In the troubleshooting tests there are several notes that are important. This list highlights these notes.

(1) As a "warning", to prevent yaw steering movement and personal injury, make sure that the transmission shift lever is in neutral and the parking brake is set before performing any troubleshooting test.

(2) When checking the hydraulic operating pressure at the load sense port, use a 0-5000 psi gage. Remember that the system operating pressures can be as high as 4200 psi. Be careful when disconnecting any hydraulic components that could be under pressure.

(3) Keep in mind contamination. Always clean the area before removing a hydraulic hose or fitting to make a pressure check.

(4) Make sure the auxiliary/steering selector valve is in the auxiliary position.

(5) Do not start the engine unless told to do so in the tests.

c. Malfunction - Hook Arm Does Not Move (Remote and Manual)

(1) Using TM 09470B-20/2, paragraph 2-8, find this malfunction in the symptom index. Read the warnings and notes carefully before making the tests.

(2) Install a gauge as listed in the test procedure. Remember, there is no hydraulic oil supplied until the auxiliary/steering selector valve is in the auxiliary position.

(3) Verify that all lines and fittings are not damaged or leaking. A damaged or kinked hose could cause a system to operate slowly.

(4) Follow each test step, in sequence, to identify the problem.

(5) If the problem is not found, continue the testing in TM 09470B-34/3, paragraph 2-2, again starting with the index.

d. Malfunction - Hook Arm does not Unload (Remote and Manual)

(1) Again, find the page for troubleshooting this malfunction from TM 09470B-20/2, paragraph 2-8, symptoms index.

(2) Read the warnings and notes thoroughly as serious personal injury can result if vehicle is not set up properly for the following test.

(3) Verify that all lines and fittings are not damaged or leaking.

(4) Remember how dirt and contamination affect a hydraulic system. Wipe all areas clean before removing or working on any components.

(5) Follow each test step closely in order to identify the problem.

(6) If the problem is not found, continue the testing in TM 09470B-34/3, paragraph 2-2, starting at the index.

e. Malfunction - Hook Arm, Main Frame, and Winch Move Slowly (Remote and Manual)

(1) Locate the troubleshooting page within TM 09470B-20/2, paragraph 2-8, symptom index.

(2) Thoroughly read all warnings, cautions and notes for this procedure as serious personal injury can result if vehicle is not set up properly.

(3) Follow each test step closely in order to identify the problem.

(4) If the problem is not found, continue the testing in TM 09470B-34/3, paragraph 2-2, starting at the index.

## 5. REPLACEMENT OF HYDRAULIC COMPONENTS

a. Hook Arm Cylinder Manifold

(1) Prepare the required parts as listed in TM 09470B-34/3, paragraph 11-3.

(2) Block the wheels of the truck to prevent personal injury.

(3) Raise the main frame and support it with a wooden block. Place a drain pan under manifold to catch oil leakage. Tag and mark the hoses before removing them. Cap the hydraulic hoses after disconnecting them.

(4) Remove the two hoses and O-rings from the two adapters and discard the O-rings. Do this carefully because the hook arm cylinder manifold will have hydraulic pressure behind it. Loosen the screws equally and cover the manifold with a clean rag to prevent personal injury from oil spray.

(5) Remove the four screws, lockwashers, and hook arm cylinder manifold from the hook arm cylinder.

(6) Remove the two O-rings from the manifold and discard the O-rings.

(7) Once the manifold is removed, disassemble the adapters, plugs, and counterbalance valves. Clean all the parts, following the cleaning procedures listed in the TM. Use caution; do not allow any foreign matter to enter into the manifold or cylinder parts.

(8) Inspect the manifold for any damage and replace it if necessary.

(9) Using new O-rings and lock-washers, lubricate the O-rings and install all parts in the reverse order of removal.

(10) Operate the system to verify proper installation.

b. Pressure Intensifier Assembly Replacement

(1) Remove the remote control receiver to access the intensifier assembly.

(2) Remove all of the intensifier tubes and fittings.

(3) Cut the cable ties as required, and place a drain pan under the tubes, hoses, and pressure intensifier, to catch the oil leakage.

(4) Remove the four locknuts and washers that hold the intensifier assembly to the mounting plate, while an assistant supports it. The intensifier assembly is heavy. Also notice the washers between the intensifier and the mounting plate.

(5) After removing the intensifier, inspect the intensifier for any damage and then repair or replace it as necessary.

(6) Installation of the intensifier assembly is done in the reverse order of removal.

(7) Operate the system to verify proper installation.

c. Manual Control Valve Removal and Repair.

**NOTE**: Before removal of the manual control valve, the remote control receiver, pressure switch, control valve harness, and the manual control valve tubes and fittings must be removed. Also the handle shaft to base must be match-marked.

(1) Loosen the four nuts on the handles and remove the handles and nuts from the handle bases.

(2) Loosen the four screws and remove the bases from control the valve.

(3) Remove the six hoses and six O-rings from the adapters. Be sure to mark all of the hoses as required and cut the cable ties as required. To catch oil leakage, place a drain pan under the tubes, hoses, and manual control valve. Cap and plug all hoses and ports when removed.

(4) Remove the six adapters and O-rings from the manual control valve.

(5) Remove the four screws, lockwashers, washers, and manual control valve from the hydraulic bracket with the aid of an assistant. Manual control valve weighs 56 lbs.

(6) Disassemble the control valve. Refer to paragraph 11-10 (Manual Control Valve Repair) in TM 09470B-34/3 for detailed instructions for disassembly, inspection, and assembly of the control valve.

(7) Place a drain pan under the manual control valve to catch oil leakage.

(8) Once the control valve is reassembled, install it on the hydraulic bracket.

(9) Install the adapters with new O-rings.

(10) Install the hoses and replace the cable ties as required.

(11) Install the bases and handles on the manual control valve.

**NOTE**: Position the handles at the positions marked during removal. Early model handle bases are retained only by tightening the handle. Newer handle bases are retained by tightening a clamp screw in the base.

(12) Install the manual control valve tubes and fittings.

(13) Install the pressure switch.

(14) Install the remote control receiver.

(15) Install the control valve harness.

(16) Check and add hydraulic fluid as needed.

(17) Conduct an operational check.

Hydraulic Filter Replacement.

**NOTE**: Place a suitable container under a filter to catch hydraulic oil. Early models have a machined head assembly; later models have a cast head assembly. All parts are interchangeable, with exception of the bowl.

(1) Remove the drain plug and O-ring from the bowl by turning it counterclockwise. Drain the bowl completely discard the O-ring.

(2) Remove the bowl and filter element from the head assembly. Discard the filter element.

**NOTE**: If the bowl was leaking, remove the O-ring and backup ring from the head assembly. Discard the O-ring and backup ring.

(3) Clean all parts and replace them as necessary.

(4) Install a new backup ring and O-ring if it was removed earlier.

(5) Position a new filter assembly on the head assembly.

(6) Install the bowl on the head assembly.

(7) Install the drain plug with a new O-ring in the bowl.

**REFERENCES**

LI 2320-12/9 SUP 1
LI 2320-12/9B
TM 2320-20/12 SUP 1
TM 2320-34/13 SUP 1
TM 2320-34/13A